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Can we cook away veterinary drug residues in food?

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When most people think of food safety they think foremost of food poisoning and bacteria. They also, one hopes, generally follow the well-understood public advice on bacterial risks and

store their food properly and cook it thoroughly. **safefood** provide clear online advice on food [storage](#) and [cooking](#) to protect the consumer. But what about chemical risks in food? Do many consumers ask the question “if drug residues are in my food, does cooking make it safe?” Or do they assume that following the good advice on bacterial risks also affords some protection against the health risks of chemical contaminants? The EU [ProSafeBeef](#) project highlighted that consumers often do not distinguish between microbiological and chemical risks in their food (“bugs and drugs”) and that safe food is perceived simply as food that is not bad for their health¹.

Is there any evidence to support the perception that correctly stored, properly cooked food will not contain harmful chemicals? There is a huge body of scientific literature addressing the sources, metabolism, toxicology and detection of veterinary drug residues in food, much of it driven by national and international food safety legislation. However, the effects of cooking on the presence or stability of such residues has received surprisingly little attention, primarily because the monitoring and regulation of drug residues is, by necessity, carried out on raw, uncooked produce of animal origin. Nevertheless, information on the fate of veterinary residues following cooking is crucial to better understand the true exposure of the consumer to these compounds.

Martin Rose and co-workers at the UK Central Science Laboratory, now part of the Food and Environment Research Agency, are to be commended for their series of ten studies between 1995

About the Authors

Dr Kevin Cooper is a Post-Doctoral Research Fellow with 20 years' experience of veterinary drug residues analysis in food and livestock by immunoassay and mass spectrometry at Queen's University Belfast and the Agri-Food and Biosciences Institute of N. Ireland (Veterinary Sciences Division). He has been particularly active in European Framework Programme projects addressing the anabolic growth promoter zeranol (Natural Zeranol), the global nitrofurans crisis (FoodBRAND FP5) and anti-parasitic compounds in beef (ProSafeBeef FP6). Since joining the Institute for Global Food Security at QUB in 2010, he has been applying similar techniques to trace analysis of human carcinogens such as heterocyclic amines. His interest in veterinary drug residues and food safety continues through his involvement in the **safefood** Chemical Residues Knowledge Network and a new project collaborating closely with the local animal feed industry.

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and 2005 which looked at a range of veterinary drug residues in food (mainly cattle, chicken and pigs) under various cooking methods we may all use at home. However, there are many veterinary drugs with varied chemical properties, many types of food which may harbour residues, and many ways of cooking. At most, only a few dozen scientific studies on this topic have been published since the mid-1990s. Much more information is required to plug the many gaps and provide data which can be incorporated into consumer exposure estimates and dietary intake calculations.

Accurately quantifying the effects of cooking on a drug residue is not as straightforward as may first appear. This is where the laboratory meets the kitchen. The analytical method, usually based on mass spectrometry, will be the same as used for raw foods, however, control of the sample pre-treatment, i.e. the cooking, is fraught with variables. Comparison of residue concentrations in the same sample before and after cooking is key. Large weight changes in your cooked sample can have a massive effect on the calculated residue concentration. The precise cooking conditions may not be as precise as you think. What temperature is being achieved within your sample? How representative of the real world is your cooking technique? Adding a sauce or other ingredients will potentially alter the temperatures achieved and the stability of your residue but may interfere with the analytical method or introduce erroneous weight changes. Residues may leach out of the sample into juices extruded during cooking. Do you analyse these juices also and can you accurately measure the volume of juices lost? Acceptance of the analytical errors involved is important – ideally



have collaborated on three significant cooking studies in recent years.

Dr Anna Gadaj is currently employed in the Institute of Global Food Security (Queen's University Belfast) as a post-doc researcher in the EU FP7 funded project DeTECH21 "Developing new technologies to meet 21st century demands in animal forensics". Previously she worked as a research officer – residue scientist in the Residue Laboratory, Food Safety Department, Teagasc Food Research Centre, Ashtown, Ireland. Her expertise is in development and validation of analytical methods using LC-MS(/MS) in food commodities.

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conclusions should be based on obvious changes in concentration rather than minor changes in a small number of samples.

The greatest unknown may be the possibility that residues of a compound apparently destroyed during cooking are in fact being converted to other unidentified products with equal or greater toxicity and which remain in the cooked food. Almost no work has been published on this subject.

safefood Chemical Residues Network members at Queen's University Belfast and Teagasc Food Research Centre, Ashtown

Our current study, about to be published in Food Additives and Contaminants Part A², showed residues of banned nitroimidazole drugs in shrimps were partially depleted by boiling (or boiling followed by microwaving to mimic the cooking of a supermarket “ready meal”) but the compounds were largely resistant to conventional grilling or frying. We previously showed that the marker residues of banned nitrofurans antibiotics in pork and pig liver were also resistant to grilling, frying, roasting and microwaving³.



A large cooking study was also carried out under the *ProSafeBeef* project. Cattle were medicated with commonly available anthelmintics (anti-worm and liver fluke medicines) containing 11 different active ingredients. Muscle and liver were roasted or shallow fried in a domestic kitchen. Raw and cooked tissues and juices expressed during cooking were analysed by liquid chromatography coupled to tandem mass spectrometry⁴. No major losses were seen for most of the residues. However, concentrations of levamisole, rafoxanide and triclabendazole fell by 11 to 42% and nitroxynil was susceptible to major breakdown during cooking (up to 96%). This was an interesting finding in light of a Teagasc study which suggested nitroxynil in milk is not destroyed during production of milk powder at high temperatures – a good illustration of the need to carefully assess residue persistence in each relevant matrix under appropriate conditions. We concluded that residues of anthelmintic drugs are generally resistant to roasting and frying but there are exceptions. This is in keeping with the studies of Martin Rose – stability of drug residues is very much compound-dependent (for example, oxytetracycline residues in beef and bovine liver are unstable, clenbuterol is not) but most veterinary drugs will, to a large extent, survive conventional cooking.

The take-home message is clearly that cooking cannot be considered a safeguard against ingestion of potentially harmful drug residues. We as consumers should not equate cooking food to kill bacteria with cooking food to destroy unwanted chemical residues.

¹ DOI: 10.1016/j.foodcont.2009.11.010

² “Determination of persistence of dimetridazole, metronidazole and ronidazole residues in black tiger shrimp (*Penaeus monodon*) tissue and stability during cooking”. Gadaj *et al*, 2014

³ DOI:10.1080/02652030701317301

⁴ DOI: 10.1080/19440049.2010.542775